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Functional reorganization of the orthographic processing network subsequent to neural injury: evidence from fMRI.

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Orthographic processing relies on left hemisphere brain regions including the visual word form area (VWFA), a functionally defined left mid-fusiform region important for normal reading and spelling (Rapp and Lipka, 2011). Lesions to this area and surrounding cortex have been associated with orthographic processing deficits as well as functional reorganization (Tsapkini et al., 2011). Characterizing the functional reorganization due to lesions in this region is critical for understanding how the remaining neural tissue facilitates residual reading and spelling performance. Key questions include whether functional reorganization leads to perilesional reorganization or whether there is functional reorganization in other brain areas. A key research challenge is the comparison of the functional activation patterns of individuals with lesions to the range of individual patterns observed in non-impaired control participants. Here we describe a novel method that addresses this challenge and allows for the characterization of functional reorganization as measured by fMRI BOLD response.

We present findings from the application of a novel two-pronged analysis approach used for comparing the activation patterns obtained during fMRI of reading in individuals with left occipitotemporal lesions to the activation patterns from non-impaired control participants. The first analysis step characterizes the variability in activations across non-impaired control participants by applying a meta-analysis technique typically used for characterizing variability across studies: Activation Likelihood Estimate (ALE) (Turkeltaub et al., 2002). This technique identifies locations with a high likelihood of yielding activation peaks in non-impaired participants. We then identify the peak activation foci in a lesioned individual's data that are nearest to the control-group foci. In the second analysis step, a Mahalanobis distance analysis is used to compare each of the activation peaks in a lesioned individual to the set of control-group peaks that contributed to the nearest ALE-identified peak. This two-pronged approach allows for a quantifiable, un-biased method to test, across the entire brain, whether or not an individual's activation foci are within or outside the range of activation locations observed in control individuals.

To date, we have employed this analysis in two individuals with left occipitotemporal lesions with similar behavioral deficits in reading and spelling. For both individuals, results reveal significantly abnormal functional activations in perilesional space as well as in other brain areas such as the left inferior frontal gyrus (see Figure 1 for results from one individual). These findings have implications for understanding the functional reorganization of orthographic processing as they indicate not only recruitment of perilesional tissue but also of other brain areas that may be involved in compensatory shifts in orthographic processing networks.

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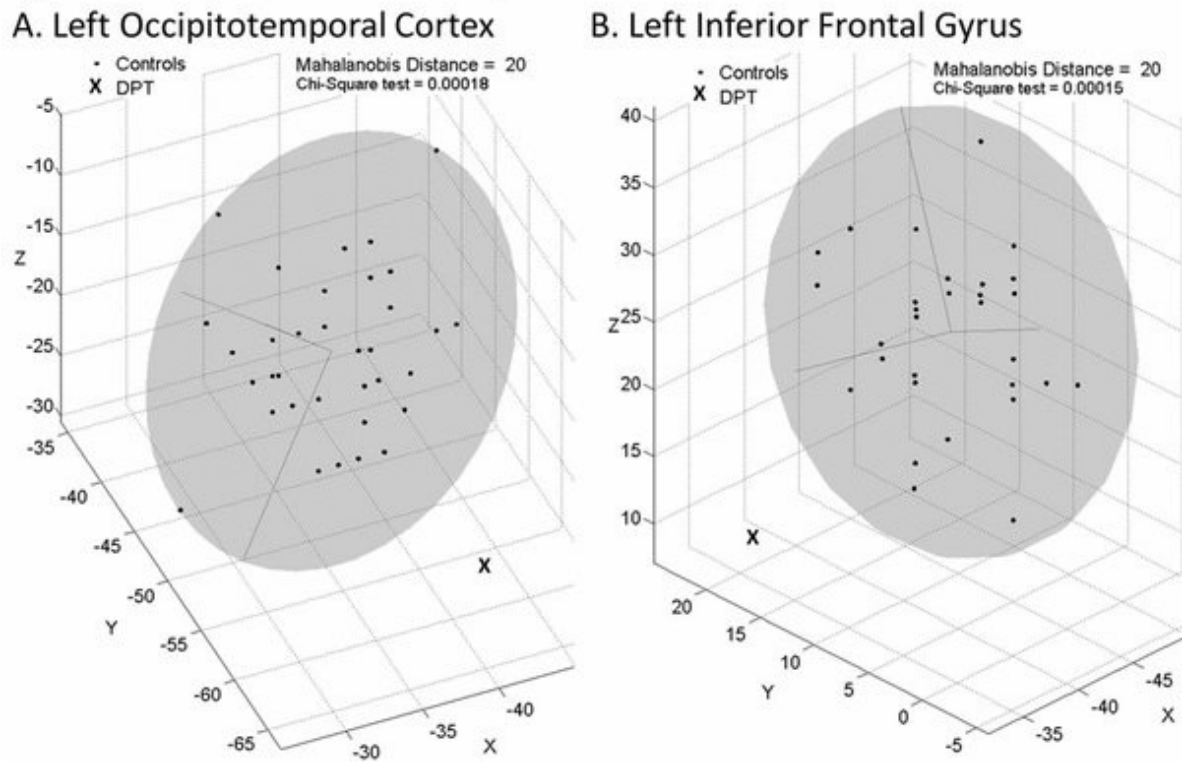
Figure1: Comparison of Control peaks to the Peaks of Patient DPT



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